MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2015/2016

EEE 7286 – ENERGY MANAGEMENT IN INDUSTRY

08 MARCH 2016
2:30 PM – 5:30 PM
(3 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 7 pages including cover page with 4 Questions only.
2. Answer ALL questions. The distributions of the marks for each question are as stated.
3. Please print all your answers in the Answer Booklet provided.

Question 1

(a) (i) Describe four different forms of energy.

[8marks]

(ii) Distinguish between renewable energy and non-renewable energy. State two examples of resources for each type of energy.

[8 marks]

(b) A drawing office of 18m x 15m is illuminated with T5 Electronic ballast florescent lamp (datasheet given in Appendix A). The maintenance factor is 0.9 and the coefficient of utilization is 0.6. Calculate

(i) The number of lamp fittings that needs to be installed in order to achieve the average illumination of as recommended in MS1525 (table shown in Appendix B)

[6 marks]

(ii) The total current drawn from the supply of 230 V, 50 Hz.

[3 marks]

Question 2

Company A decided to perform economic assessment on their electric motors (three phase induction motors). Most of the motors in the company are 15 years old, hence they are below IE1 standard. At the beginning, they selected 5 different motors based on their sizes for the assessment. Details of those motors are given below in Table Q2.

Table Q2

	kW	Pole	Voltage (V)	Rated Speed (RPM)	Actual Running Speed. (RPM)	Rated Current (A)	Actual Running Amps. (A)	Running Hour per day
Motor 1	11	2	400	2870	2860	21	15.75	24
Motor 2	7.5	2	400	2870	2865	15	7.5	24
Motor 3	45	2	400	2983	2980	87	65.25	24
Motor 4	30	2	400	2983	2978	58	43.5	24
Motor 5	15	2	400	2950	2945	30	22.5	16

Given that maximum demand charge is RM 30.8/ kW and tariff rate is RM 0.25/kWhr. The company operates 25 days in a month.

a) Calculate the total losses in kWhr per month based on details given in Table Q2. Given approximate power factor values for the motors are 0.9 at full load, 0.86 at ¾ load and 0.8 at half load.

[9 marks]

Continued...

b) Calculate again the total losses in kWhr per month if all the motors are IE2 motors. (Efficiency for IE2 motors are given in Appendix C)

[6 marks]

c) Motor 3 is used to drive a fan. The average flow rate for the fan is 50% and currently the flow rate is controlled using a damper. Explain how variable speed drives can improve the efficiency of the fan. Calculate the payback period for the cost involved for the improvement. Given that the cost of variable speed drives and installation is RM60,000, and electricity tariff is RM0.40/unit)

[10 marks]

Question 3

(a) The capital cost of a power generating equipment in a power plant is RM 200 million. The useful life of the equipment is 25 years and its salvage value is 7.0% of its total cost. Determine the amount of money to be deposited annually for replacement by sinking-fund method. Assume that the annual compound interest is 5.0%.

[5 marks]

(b) State and explain any five tariff structures used by the utilities.

[10 marks]

(c) An industry consumes 3 million unit energy per annum with a maximum demand of 2000 kW at 0.85 pf lagging. They use Tariff E1 (Malaysian Utility Tariff) for medium voltage industry.

(i) Calculate the annual bill if the tariff rate is as follows:
Maximum demand charge = RM29.60/kW
Energy charge = RM0.3370/kWhr

[4 marks]

(ii) Explain three solutions to reduce maximum demand of the industry.

[6 marks]

Continued...

Question 4

(a) Define building envelope and state two solutions to increase the thermal energy efficiency of a building.

[4 marks]

(b) Define indoor air quality for a building. Explain three control strategies for the indoor air quality.

[5 marks]

(c) What is a captive power plant? Discuss the need for a captive power plant in an industry.

[7 marks]

(d) A captive power plant (CPP) located in an industry is operating in parallel with the grid. The total power requirement of the industry is 50 MW at 0.85 power factor lagging. Total real and reactive power losses in the distribution system of the industry are 2 MW and 1.5 MVAR, respectively. The real and reactive powers generated by the captive generator are 30 MW and 20 MVAR, respectively. It is desirable to import power from the grid at unity power factor. A capacitor bank is connected at the 11 kV of the CPP bus to adjust the power factor. Calculate the real and reactive powers to be imported from the grid and the value of capacitor connected at the 11 kV bus.

[9 marks]

Continued...

Appendix A

Product datasheet

OSRAM

HE 14 W/827

LUMILUX T5 HE | Tubular fluorescent lamps 16 mm, high efficiency, with G5 base

Product datasheet

Technical data

Electrical data

Nominal voltage	220 V
Nominal wattage	14.0 W
Rated lamp efficacy (HF data 25 °C)	86 lm/W
Rated wattage	14.00 W

Photometrical data

Color rendering index Ra	≥80
Rated luminous flux	1200 lm
Luminous flux at 25 °C	1200 lm
Luminous flux at 35 °C	1350 lm
Light color	827
Color temperature	2700 K
Nominal luminous flux	1200 lm
Light color (designation)	LUMILUX INTERNA
Rated LLMF at 2,000 h	0.95
Rated LLMF at 4,000 h	0.92
Rated LLMF at 6,000 h	0.91
Rated LLMF at 8,000 h	0.90
Rated LLMF at 12,000 h	0.90
Rated LLMF at 16,000 h	0.90
Rated LLMF at 20,000 h	0.89

Continued…

Appendix B

Table 10. Recommended average illuminance levels

Task and Applications	Illuminance (Lux)	Minimum CRI
a) Lighting for infrequently used area:		
- Minimum service illuminance	20	30
- Interior walkway and car-park	100	40
- Hotel bedroom	100	60
- Lift interior	100	40
- Corridor, passageways, stairs	100	40
- Escalator, travellator	150	40
- Entrance and exit	100	60
- Staff changing room, locker and cleaner room, cloak room, lavatories, stores.	100	60
- Entrance hall, lobbies, waiting room	100	60
- Inquiry desk	300	80
- Gate house	200	80
b) Lighting for working interiors		
- Infrequent reading and writing	200	80
- General offices, shops and stores, reading and writing	300 - 400	80
- Drawing office	300 - 400	85
- Restroom	150	80
- Restaurant, canteen, cafeteria	200	80
- Kitchen	150 - 300	80
- Lounge	150	60
- Bathroom	150	80
- Toilet	100	60
- Bedroom	100	80
- Class room, library	300 - 500	80
- Shop/supermarket/department store	200 - 750	80
- Museum and gallery	300	80
c) Localised lighting for exacting task		
- Proof reading	500	80
- Exacting drawing	1000	80
- Detailed and precise work	2000	80

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Appendix C : IE2 Motors

TEFC, Class F, 40°C Ambient Temperature, IEC; Design N Continuous Duty, S. F. 1.0 380V/50Hz

OUTPUT				EFFICIENCY			POWER FACTOR			CURRENT		TORQUE				ROTOR GD²	NOISE SOUND POWER	APP WEIGHT
kW	hp	FULL LOAD rpm	FRAME NO.	FULL LOAD (%)	3/4 LOAD (%)	1/2 LOAD (%)	FULL LOAD (%)	3/4 LOAD (%)	1/2 LOAD (%)	FULL LOAD (A)	LOCKED ROTOR %FLT	FULL LOAD kg-m	LOCKED ROTOR %FLT	PULL UP %FLT	BREAK DOWN %FLT	kg-m²	NO-LOAD dB(A)	kg
7.5	10	2905	132S	88.1	88.6	87.6	84.5	80.5	71.5	15.3	680	2.499	190	165	250	0.066	97	67
		1465	132M	88.7	89.0	88.8	85.5	80.5	70.0	15.0	760	4.955	230	165	280	0.133	90	78
		960	160M	87.2	88.0	87.0	81.5	76.5	66.0	16.0	600	7.561	210	185	225	0.363	82	110
11	15	2940	160M	89.4	89.4	88.6	91.5	89.0	83.0	20.4	830	3.703	220	155	270	0.154	97	105
		1485	160M	89.8	90.1	89.5	88.5	85.0	77.5	21.0	730	7.432	205	155	255	0.297	90	110
		965	160L	88.7	89.2	88.6	81.5	76.0	65.0	23.1	685	11.280	245	230	270	0.558	85	140
15	20	2925	160M	90.3	90.3	90.2	93.0	91.5	88.0	27.1	765	4.963	230	155	240	0.192	100	120
		1470	160L	90.6	91.3	90.5	86.5	82.5	73.5	29.1	785	9.876	235	185	280	0.396	94	130
		975	180L	89.7	89.7	89.4	80.0	74.0	62.5	31.8	760	14.890	265	185	315	1.342	88	200
18.5	25	2945	160L	90.9	91.7	90.5	92.5	90.5	86.0	33.4	880	6.162	265	175	280	0.237	100	135
		1470	180M	91.2	92.0	91.0	85.0	82.5	75.5	36.3	630	12.340	180	175	275	0.654	94	180
		975	200L	90.4	91.1	90.2	82.5	79.0	70.5	37.7	610	18.610	200	185	220	1.604	88	250
22	30	2945	180M	91.3	91.5	91.0	90.0	88.0	82.5	40.7	800	7.394	220	175	280	0.283	100	175
		1475	180L	91.6	91.8	91.5	84.0	80.5	72.5	43.4	710	14.760	195	150	230	0.712	94	190
		975	200L	90.9	91.1	90.9	82.0	78.5	69.5	44.8	680	22.330	225	180	220	1.912	88	270
30	40	2955	200L	92.0	92.0	90.8	90.0	89.0	85.0	55.0	775	9.825	185	140	275	0.521	102	240
		1475	200L	92.3	92.3	91.7	87.5	84.5	77.5	56.4	790	19.680	205	185	245	1.220	98	255
		975	225M	91.7	92.0	91.5	86.0	83.5	76.0	57.8	615	29.780	175	155	210	2.442	91	325
37	50	2950	200L	92.5	92.0	91.3	90.5	89.5	85.5	67.2	845	12.30	205	140	240	0.663	102	270
		1480	225S	92.7	92.8	92.1	87.0	84.0	77.0	69.7	710	24.52	190	160	245	1.649	98	320
		980	250M	92.2	92.4	91.9	85.0	81.0	72.5	71.7	640	37.03	180	180	220	3.373	91	410
45	60	2965	225M	92.9	92.3	90.9	90.5	87.5	81.0	81.3	875	14.69	160	155	320	1.074	104	320
		1475	225M	93.1	93.3	92.9	86.5	83.5	76.5	84.9	690	29.53	190	160	270	1.731	100	330
		985	280S	92.7	92.6	92.0	84.0	81.0	73.5	87.8	650	44.52	140	115	230	6.400	94	580

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